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Method for coating holes in substrates

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(54) Method for coating holes in substrates

(57) The invention refers to the field of electronics. The purpose is to eliminate the high outlay and limited applicability of known methods. The object is to eliminate any further need to use known methods, but to achieve

identical or better film properties in the metallization layer. According to the invention, the coating material is made available in a hole at a distance from the hole edges, or below the hole and also at that distance. Arranged above the particular hole to be coated is a laser device which emits a laser beam in jet mode. At normal ambient pressure, the laser beam is steered so that its focal spot lies in the center of the coating material, or so that the latter, in dynamic mode, is moved along a circle whose diameter is smaller than the hole diameter. The area of application of the invention is the manufacture of multiple-plane circuits. Figure 1

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Title of the invention

Method for coating holes in substrates.

Area of application of the invention

The invention refers to the field of electronics. It concerns a method for coating holes in substrates. The holes are produced so as to implement electrically conductive connections between the individual planes of multiple-plane circuits.

Characteristics of known technical solutions

In order to create electrically conductive connections between the front and back sides of circuit substrates, or between the front and/or back side and internal conductor planes, it is known to introduce into the substrates holes which must be metallized. A number of methods for coating the hole walls are known.

The method of electroless metal deposition in holes with subsequent galvanic reinforcement is of only limited applicability due to the low adhesion of the layers thus deposited, and the limited range of materials (DE 20 59 425).

Vacuum metallization of holes introduced perpendicular to the surface is also known; for metallization of the hole walls on all sides, the substrate must be moved

simultaneously, during coating, about at least two different rotation axes. These throughplatings must also be subsequently galvanically reinforced (DE 21 47 573, DE 24 43 287).

Also known are throughplating methods in which the holes are overprinted with a conductive silk-screened paste, and the silk-screened paste is then sucked through the holes by means of vacuum, thus effecting metallization of the holes (DE 29 26 335).

DE 25 58 361 discloses a method for the manufacture of metallized holes in which a conductive paste is first pressed onto the substrate surface and into the holes. After a sintering operation the paste partly volatilizes, so that only a metal layer remains on the inner walls.

Also known is a method in which the walls of the holes are metallized by the fact that first the holes are filled with a metallic paste and then the substrate is spun so that as a result of the centrifugal forces, on the one hand excess metal paste is removed, and on the other hand the walls of the holes are uniformly coated with metal paste.

The substrate is then fired in order to consolidate the paste (DE 25 38 454).

Document DE 31 45 584 describes a method for throughplating a circuit board in which an elastically deformable pressure plunger presses the conductive silk-screened paste into the hole. This method cannot be used for small hole diameters.

Also known in order to metallize the aforesaid holes is a gas atomization method in which evaporation of the metallization layer is performed, in a vacuum, in the vicinity of the holes at pressures sufficiently high that particles arrive from every angle of the half-space and coating of the holes is thus achieved.

A similar effect may be expected if the known atomization method is used at high pressures for the metallization of holes.

All of the aforesaid methods have technical and economic disadvantages, particularly with regard to the electrical load capacity and reliability of such connections. In addition, applicability is greatly limited

in terms of processes and materials.

Purpose of the invention

The purpose of the invention is to create a method for coating holes in substrates which eliminates the aforesaid disadvantages of the known technical solutions, in particular the relatively high outlay and limited applicability.

Presentation of the invention

The object of the invention is to discover a new method for coating holes in substrates, which eliminates the need for further use of any previously known method for coating (metallizing) said holes, but achieves identical or better film properties in the metallization layer.

The object is achieved, according to the invention, by the fact that the coating material is first made available in a hole at a distance from the hole edges, or below the hole and also at that distance. A laser device is arranged above the particular hole to be coated. The laser beam emitted from said laser device is steered in a gas stream (jet mode) and at normal ambient pressure (i.e. no vacuum)

so that its focal spot lies in the center of the coating material or so that, with the laser in dynamic mode, the focal spot is moved along a circle whose diameter is less than the hole diameter.

Advantageously, the distance of the coating material from the hole edges is established in the range from one-twelfth to one-sixth of the hole depth.

In a further embodiment of the invention, the laser beam is focused as a function of the hole diameter.

It is furthermore advantageous to make the coating material available in the solid state. If it is arranged in the hole, it can be fitted therein as a rod.

Be it noted expressly here that although it is known to drill holes in substrates with laser beams and thereby to produce conductive hole walls, a layer is nevertheless not applied onto the hole walls in that context; instead, chemical reactions of the hole wall material are simply prevented due to the presence of a vacuum (DE 31 03 986).

The use of a laser to evaporate materials which are to be deposited onto planar substrates is, of course, also

known. The conditions present, and problems in the application of a thin layer in a narrow hole, are, however, substantially more complex. It is thus in no way to be expected, based on the physical circumstances and in particular on knowledge of how production of a uniform layer depends on the free path length of vapor particles, that with a free path length of less than 1 micrometer as achieved with the method according to the invention, the required uniform and continuous metallization layer can be obtained for the hole wall.

Exemplifying embodiment

The invention will be described below in more detail with reference to an exemplifying embodiment. In the appended drawings:

Figure 1: shows a sectioned depiction through a substrate having a hole, the coating material being arranged in the hole;

Figure 2: shows a sectioned depiction through a substrate having a hole, the coating material being arranged below the hole.

To manufacture a multiple-plane structure which consists in the simplest case, as will be described here, of a ceramic substrate metallized on both sides, one or more holes are introduced into the latter with, for example, a laser beam. To achieve a conductive connection between the two conductor planes 3, 5, the hole must be metallized.

According to the invention, a hole 7 having a diameter of 600 micrometers, which in particular has a conical shape, is drilled into a ceramic substrate 4 having a thickness of 630 micrometers.

Coating material 6 is then arranged inside hole 7 (Figure 1), specifically at a distance a of 100 micrometers from the hole edges. A metal in rod form can be used, for example, as coating material 6. For further implementation of the method, a laser device 1 is arranged above hole 7. Said device can, according to the invention, be a CO2 laser in jet mode. There are no particular requirements in terms of ambient pressure (no vacuum). The atmosphere should simply be one of argon or nitrogen at a pressure lower than

2 x 105 Pa. Laser beam 2 is focused and steered, in accordance with the hole diameter that is present, so that its focal spot lies in the center of coating material 6. With the laser in dynamic mode (laser head displacement), the focal spot is moved along a circle on coating material 6 whose diameter is less than the hole diameter.

In Figure 2, coating material 6 is arranged below hole 7 on a support 8. The term "support" can also be understood as a evaporator crucible. In this case as well, the distance a between coating material 6 and the hole edge is, for example, 100 micrometers. When laser beam 2 strikes coating material 6, the latter is evaporated explosively and is deposited as a thin layer (0.1 micrometer) on the (inner) wall of the hole. No deposition of material takes place perpendicular to this coated surface, i.e. on the substrate surface. The electrically conductive layer resulting from selective coating of the hole wall has a contact resistance of less than 1 ohm.

The method according to the invention allows broad applicability for a wide variety of coating materials and

substrate materials. The metallization layer that is produced on the hole wall possesses a uniform thickness over its entire area, as well as good adhesion to the ceramic. Its properties are comparable to those of a sputtered layer.

Because the laser device is used both to drill the holes and to coat them, outlay is low.

The method can also be used, of course, if more than two conductive planes, on or in one or more substrates, are to be connected in electrically conductive fashion.

Claims

1. A method for coating holes in substrates, as created in particular for electrically conductive connections between the individual planes of multiple-plane circuits, wherein the coating material (6) is first made available in a hole (7) at a distance (a) from the hole edges, or below the hole (7) and also at that distance (a); and a laser device (1) is then arranged above the hole (7) to be coated, a laser beam (2) emitted therefrom being steered in a gas stream (jet

mode) and at normal ambient pressure so that its focal spot lies in the center of the coating material (6) or so that, with the laser in dynamic mode, the focal spot is moved along a circle whose diameter is less than the hole diameter.

2. The method as defined in Claim 1, wherein the distance (a) of the coating material (6) from the hole edges is implemented in the range from one-twelfth to one-sixth of the hole depth.

3. The method as defined in Claim 1, wherein the laser beam (2) is focused as a function of the hole diameter.

4. The method as defined in Claim 1, wherein the coating material (6) is made available in the solid state.

5. The method as defined in Claim 4, wherein the coating material (6) is fitted into the hole (7) as a rod.

- Accompanied by 1 sheet of drawings _